

# Vacuum Stabilization of the Spleen in Laparoscopic Splenectomy

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## ABSTRACT

**Background and Objectives:** Recovery from laparoscopic splenectomy is greatly enhanced when compared with recovery from the laparotomy approach, yet a minority of spleens are removed laparoscopically. The spleen is smooth, rounded, and vascular, making it difficult to directly grasp, stabilize, or retract laparoscopically. The LiVac Retractor is a laparoscopic liver retractor comprising a soft silicone open ring that apposes 2 substantially planar surfaces when a vacuum is applied. It was evaluated for its efficacy in stabilization of the spleen during 2 laparoscopic splenectomies.

**Methods:** The 2 patients gave consent for laparoscopic splenectomy with splenic retraction using the LiVac Retractor. The entire 3-port laparoscopic procedure was video recorded, with the resected spleens weighed as wet specimens. The patients' postoperative courses are described.

**Results:** The spleen was retracted securely for the duration of the hilar dissection in both patients. Exposure of the splenic hilum was excellent. There were no visible signs of injury to either spleen and recovery of both patients was unremarkable.

**Conclusion:** The LiVac Retractor provided stable retraction and excellent exposure of the splenic hilum during both laparoscopic splenectomies, without organ injury. Early hilar dissection with vascular control was facilitated, reducing the risk of bleeding from other components of the dissection.

**Key Words:** retraction, spleen, splenectomy, vacuum, laparoscopy, laparoscopic splenectomy.

## INTRODUCTION

Retraction and stabilization of the spleen can be a challenge in laparoscopic splenectomy. Exposure of the hilum is limited in supine patients, and the spleen has a propensity to fall on its hilum when the patient is in the left lateral position.<sup>1</sup> Furthermore, the spleen's smooth and rounded contour is difficult to grasp directly and lends itself to rocking and slipping against retracting instruments. Its highly vascular nature renders it prone to bleeding when traumatized. These difficulties are exacerbated in patients with larger spleens in whom hand assistance may be advantageous.<sup>1,2</sup> This report is an account of vacuum retraction and stabilization of 2 enlarged spleens against the diaphragm during splenic hilar dissection.

Recovery from a laparoscopic approach to splenectomy is much enhanced compared with recovery from laparotomy,<sup>2,3</sup> and yet only 13.3% of splenectomies in the United States are completed laparoscopically, with a further 5.3% being converted from laparoscopy to open (28% conversion rate).<sup>3</sup> These statistics contrast with an international expert panel finding<sup>2</sup> that the laparoscopic approach is indicated for most benign and malignant hematologic diseases. Any means, therefore, of improving the conditions of surgery for the laparoscopic approach would be advantageous for patient outcomes and cost of healthcare delivery.

The LiVac Retractor (Livac Pty Ltd, Warrnambool, VIC, Australia) is a novel medical device, CE Marked (ie, the product complies with the essential requirements of the relevant European health, safety and environmental protection legislation) and included on the Australian Register of Therapeutic Goods (ARTG), with first clinical use in 2013.<sup>4</sup> It was not registered with the U.S. Food and Drug Administration at the time of this writing. It comprises a soft silicone ring connected to suction tubing that exits the abdomen alongside existing laparoscopic ports and therefore does not require an additional incision (**Figure 1**). When the ring is sandwiched between 2 substantially planar organs and controlled suction is applied to the tubing, a vacuum is created between the 2 organ surfaces, thereby joining them. The ensuing seal creates a closed system that does not affect the positive-pressure pneumoperitoneum. Although the LiVac Retractor was designed for the retraction of either lobe of the liver against the

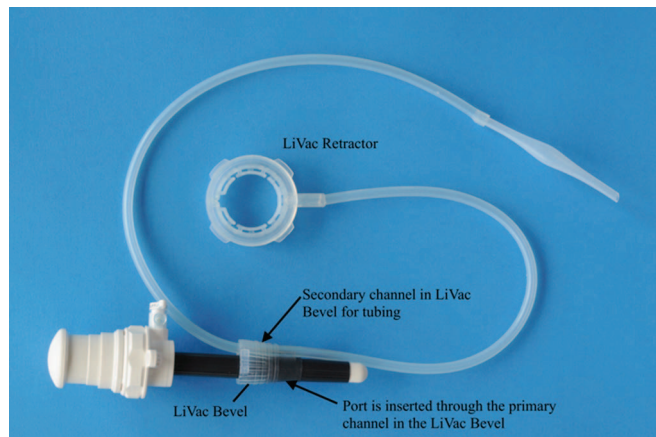
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**Figure 1.** LiVac Retractor System.

diaphragm, there is no theoretical impediment to its use between any 2 solid substantially planar surfaces. Its current intended purpose is as a liver retractor; hence, its application in the operations described herein was off label. The requirement for splenectomy in these patients with splenomegaly provided an opportunity for preliminary evaluation of the retractor for this surgery.

## METHODS

### Clinical background

Patient 1 was a 71-year-old man who presented with 6 weeks of anorexia, 7.5 kg weight loss, dyspnea, drenching sweats, and malaise. He had new-onset anemia, thrombocytopenia, and paraproteinemia. A computed tomographic scan demonstrated splenomegaly 17 cm in length. His treating hematologist referred him for laparoscopic splenectomy for suspected lymphoma.

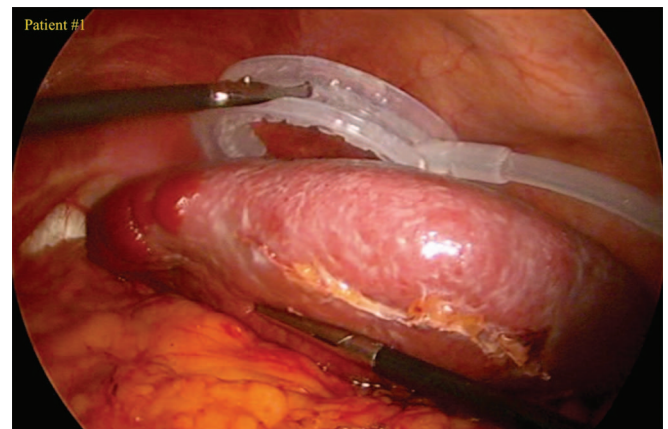
Patient 2 was an 18-year-old woman with warm-type hemolytic anemia who had relapsed after an initial response to rituximab and was referred from her treating hematologist for laparoscopic splenectomy.

Both patients provided consent for laparoscopic splenectomy with use of the LiVac Retractor, which included a full disclosure of the author's interests in the company.

### Surgical Technique

The patients had their operations about a month apart. Both were anesthetized and positioned in a right semilateral decubitus position, similar to that described by Feldman.<sup>1</sup>

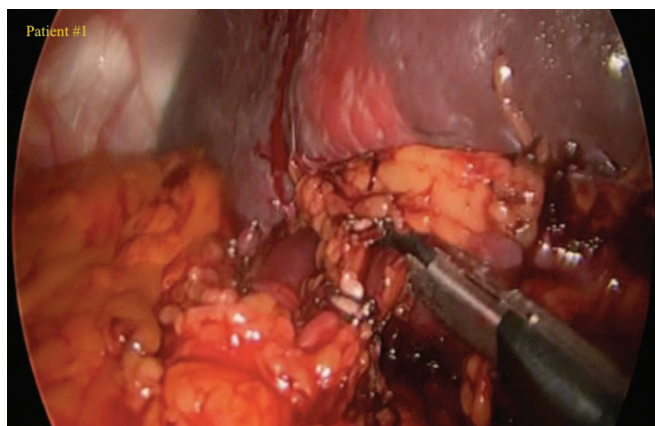
In patient 1, given the large size of the spleen, a GelPort



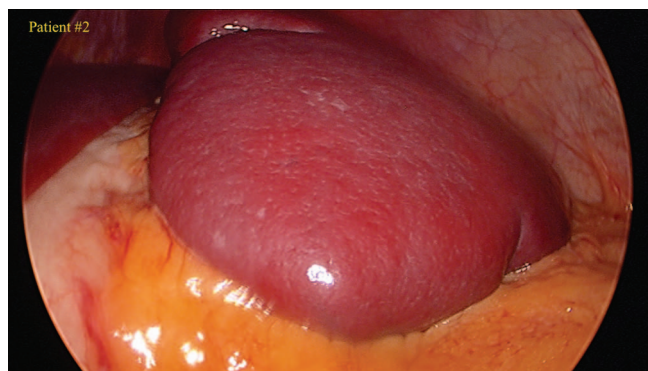
**Figure 2.** Positioning the LiVac Retractor in patient 1.

(Applied Medical, Rancho Santa Margarita, California, USA) was inserted through a small incision in the left iliac fossa, keeping the fascial defect minimal with the view that it could be extended in case hand assistance was needed. As it turned out, no hand assistance was necessary, and the GelPort need not have been used. A 12-mm Versaport Bladeless Optical Trocar (Medtronic, Minneapolis, Minnesota, USA) was placed through the gel and pneumoperitoneum was established. Versaport Bladeless Optical Trocars (5 mm; Medtronic) were inserted under direct visual guidance into the epigastrium and left rectus, a short distance superolateral to the umbilicus. A 5-mm 30° laparoscope was used through this middle port, allowing separation and triangulation of the surgeon's hands.

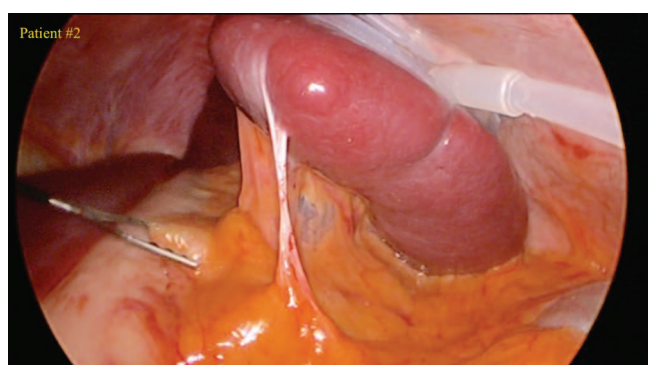
The adhesions to the lower pole of the spleen were mobilized with a LigaSure 5-mm blunt-tip vessel sealer and divider (Medtronic), extending only a short distance up the lower posterolateral splenic attachments to expose the lower pole. Even with no lateral mobilization of the spleen, its large size caused the hilum to hang forward, obscuring the vessels. Hence, a large LiVac Retractor was inserted via the GelPort, with the suction tubing drawn back through the gel and placed between the spleen and diaphragm over the left inner chest wall (**Figure 2**). Had the 12-mm port been used alone without the GelPort, the LiVac Retractor would have been inserted by withdrawing the port, inserting the LiVac Retractor through the tract, then replacing the 12-mm port alongside the tubing and thereby sharing the incision, as per the Instructions for Use. The pressure regulator was set at  $-300$  mm Hg and a vacuum was applied. The patient was rotated left side up, suspending the spleen and providing excellent hilar exposure. No attempt was made to dissect the gastrosplenic ligament and its associated short gastric and gas-



**Figure 3.** Hilum exposure with vessel ligation in patient 1.



**Figure 4.** Spleen in patient 2 before dissection and retraction.



**Figure 5.** Retraction of spleen in patient 2 before dissection.

troepiploic vessels. Instead, the dissection was taken directly to the splenic hilum, where the superior and inferior main branches of the splenic artery were dissected with a right-angle dissector, then individually divided between Endo Clips (Endo Clip II 10-mm Clip Applier; Medtronic), followed by their associated veins (**Figure 3**, showing the vascular demarcation of the spleen). After devascularization of the spleen, further mobilization of the superior gastrosplenic attachments was performed with the LigaSure sealer divider, then the suction was released from the LiVac Retractor by disconnecting the suction tubing from the suction hose externally with an artery clamp placed on the suction tubing to prevent CO<sub>2</sub> leakage. The spleen was reflected forward, and the superolateral dissection was completed. The organ was placed into a large sterile drawstring bag and digitally morcellated to remove it. No drains were inserted. The wounds were closed and dressings applied. The duration of surgery from initial incision to application of wound dressings was 105 minutes; however, the duration of retraction with the LiVac Retractor was 30 minutes. The spleen weighed 554 g.

A more minimally invasive approach was used in patient 2: a metal Hasson port through a vertical incision in the umbilicus, a 5-mm Versaport Bladeless Optical Trocar (Medtronic) midepigastriac port, and a needlescopic 2.3-mm Teleflex MiniLap Clutch Grasper (Teleflex, Morrisville, North Carolina, USA) high up in the epigastrium. Again, the spleen was large and fell forward onto its hilum, obscuring the hilar vessels (**Figure 4**). A small LiVac Retractor was inserted through the wound of the Hasson port, with the tubing of the retractor brought back through the secondary channel of the LiVac Bevel, replacing the cone of the Hasson port (**Figure 1**). The spleen was suctioned against the inner chest wall with  $-300$  mm

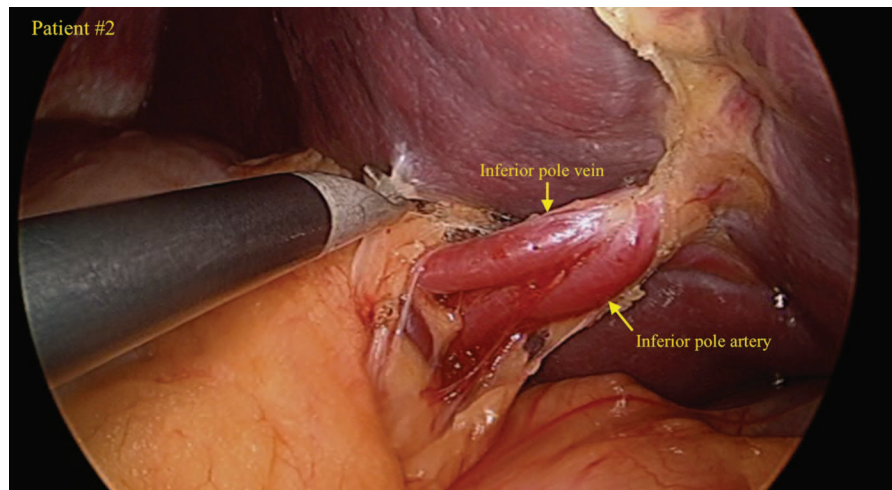
Hg regulated vacuum pressure, and the patient was rotated left side up (**Figure 5**). The splenic vessels were dissected as in patient 1, dividing the inferior and then the superior pole vessels with a LigaSure between 5-mm Endo Clip III clips (Medtronic) (**Figures 6 and 7**). In each case, the arteries were divided before the veins. In patient 2, the entire splenic mobilization was completed from the medial approach without having to release the LiVac Retractor. The total duration of splenic retraction with the LiVac Retractor was 39 minutes, which included complete mobilization (**Figure 8**). The duration of just the hilar dissection was similar to that in the first case. There was no trauma to the splenic surface. The 388-g spleen was removed in an Endo Catch II 15-mm Specimen Pouch (Medtronic) which was inserted directly through the umbilical wound after removal of the LiVac Retractor and Hasson port. It was morcellated to facilitate removal of the organ.

## RESULTS

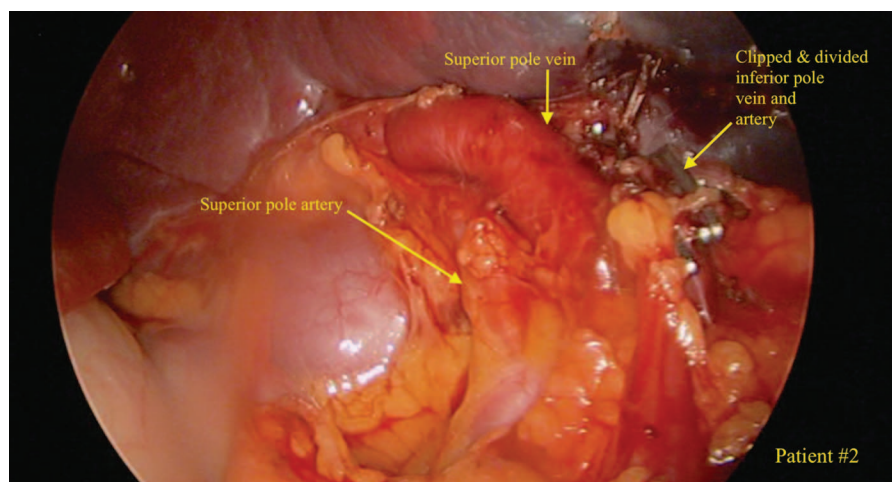
### Surgery

The LiVac Retractor maintained the spleen in an elevated position continuously during the application of the suc-





**Figure 6.** Exposure of lower pole vessels in patient 2.



**Figure 7.** Exposure of upper pole vessels in patient 2.

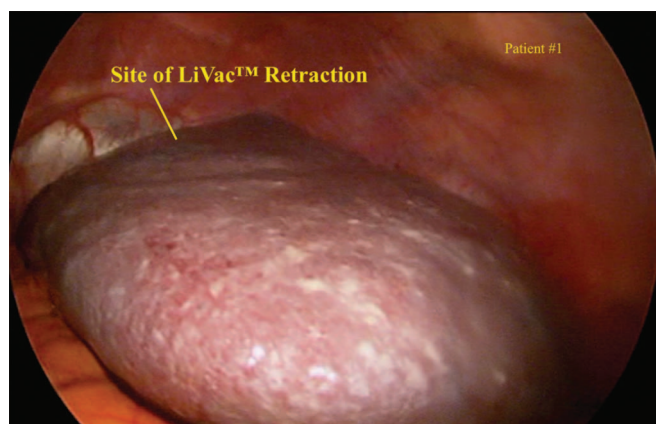
tion in both cases. When released, both demonstrated some initial embossing of the surface contour, which flattened out completely within a few minutes. There was no bleeding at the spleen surfaces where they had been retracted (**Figures 9** and **10**). No hand assistance was needed through the GelPort, and no additional laparoscopic ports were necessary for retraction by the surgical assistant, whose only duty during the laparoscopic procedures was to hold the laparoscope.

### Postoperative Course

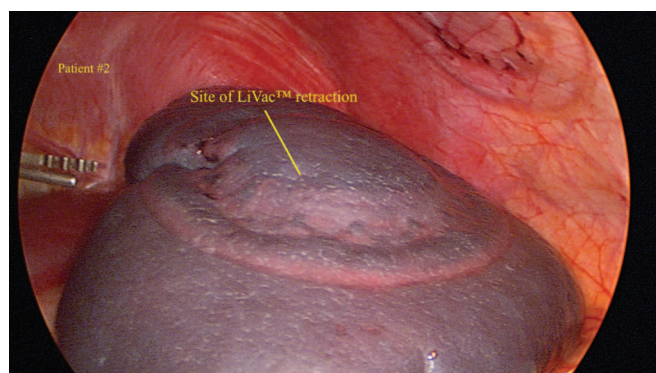
Both patients made unremarkable recoveries, requiring minimal analgesia (**Figure 11**).



**Figure 8.** Appearance of retracted spleen in patient 2 after hilar dissection.



**Figure 9.** Surface of spleen after retraction in patient 1.



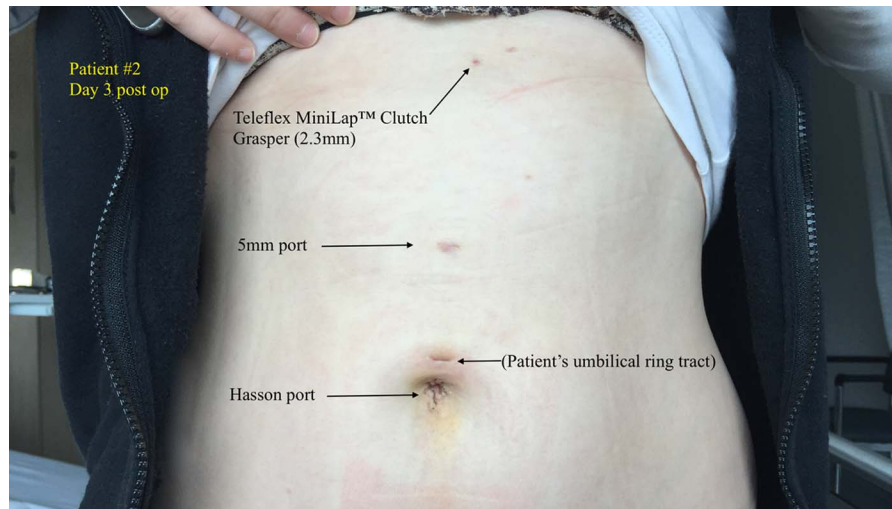
**Figure 10.** Surface of spleen after retraction in patient 2.

## DISCUSSION

Stable and atraumatic retraction of the spleen is necessary to adequately expose the hilar vessels for dissection and transection. Typically, this maneuver is achieved by the insertion of a laparoscopic instrument through an assistant's port. Patient positioning is also vital,<sup>1</sup> and yet the spleen tends to fall forward onto its hilum during increasing left-side-up rotation. The quality of retraction and avoidance of traumatic bleeding is therefore dependent on a skilled assistant and is more difficult to achieve with larger spleens. The pancreas also commonly lies close to the splenic hilum and is at risk of injury if traumatized by a linear cutting stapler.<sup>1</sup> The use of a vacuum mechanism for atraumatic splenic retraction in humans has been reported<sup>5</sup>; however, that experimental device was akin to a suction cup on a handle inserted through a port, whereas the LiVac Retractor is a registered hands-free medical device that does not require an additional port. Following are key observations from these first 2 uses of the LiVac Retractor in a laparoscopic splenectomy:

- It took ~2 minutes from the time of insertion of the retractor to achieve suction retraction in both cases.
- Retraction was secure, and by the nature of the vacuum mechanism, there was no sliding or untoward movement.
- The spleens were held flush against the inner chest wall, providing optimal exposure of the hilum.
- The quality of the hilar exposure allowed for a direct and selective dissection of the vessels, dividing the arteries before the veins, both taking ~30 min, and keeping well clear of the pancreas.
- Early control of the hilar vessels was attained, reducing the risk of bleeding from other components of the dissection.
- As the retractor was on the other side of the spleen, it remained out of sight during the period of retraction, with no interference with the surgical field or instruments.
- No assistant's retractor was required; hence, there was no risk of an assistant causing injury, and the surgery had fewer ports, by virtue of only 3 incisions, 2 of which were 5-mm ports in patient 1. Patient 2 had a 2.3-mm needlescopic portless grasper instead of a 5-mm port at the epigastrium.
- The assistant had a free hand and was therefore able to use the angled laparoscope to maximum effectiveness through rotation of the light lead.
- The retraction was atraumatic.
- Although a GelPort was used in anticipation of possible hand assistance in patient 1, no hand assistance was needed. The LiVac Retractor is designed to share the same incision as existing 10–15-mm ports, and a Gelport is not necessary for its use. A more cosmetic approach was used with a transumbilical port in patient 2. The LiVac Retractor is also well suited to single-port laparoscopic surgery, as no additional trocar is necessary.
- The operative times of 105 minutes for patient 1 and about 60 minutes for patient 2 were expeditious for splenomegaly, compared with published data.<sup>2,3</sup>

This account represents our initial experience with the use of the LiVac Retractor for laparoscopic splenectomy in 2 patients. There is a difference in both the mortality and morbidity rates<sup>3</sup> between laparoscopic and open splenectomies, not to mention the increased length of stay associated with the latter. Greater length of stay has a substantial impact on the cost of healthcare delivery. Further investigation of this application of a novel retractor is warranted to determine whether these observations are reproducible, in particular the safety profile, given the vascularity of the spleen and whether it has the potential



**Figure 11.** Patient 2 on postoperative day 3.

to improve the adoption and success of the laparoscopic approach to splenectomy. Of note, the author has used the LiVac Retractor on friable steatotic livers with no injury. The LiVac Retractor was initially conceived as a liver retractor and is registered as such; however, applications will be made to broaden this indication for use in due course, according to regulatory requirements.

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